PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Improvements in or relating to Contact Lenses

I, JOHN TREVOR DE CARLE, a British Subject, of 73, New Bond Street, London, W.1, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to contact lenses and has for one of its objects the provision of a lens which can be worn continuously, or for longer periods than is possible with conventional lenses, without detriment or damage to the cornea of the eye.

With the conventional type of contact lenses made of hard plastics material it is generally difficult for the wearer to keep a lens in place for long periods until after an extended period of adjustment, which may comprise some 10—15 attendances with the optician. Furthermore, it is necessary to shape the conventional type of hard plastics lens to an individual eye, as the lens itself is insufficiently flexible to conform to varying contours. In addition the outer rim of the lens has had to be finished very carefully to ensure that no damage is caused to the eye during wearing periods.

An attempt has been made to overcome this problem by the use of a softer plastics material for the lens but this has led to increasing difficulties as regards the optical and other properties of the lenses themselves.

According to the invention therefore there is provided a plastics contact lens assembly which comprises a contact lens having a peripheral skirt which is shaped to conform with the surface of the eyeball and which is constructed from a plastics material which is softer and more flexible than that of the lens. Preferably the concave back surface of the lens, i.e. the surface which is adapted to contact the eyeball is provided with a layer of plastics material which is softer and more flexible than that of the lens and is integral with the skirt so as to form a continuous surface of soft plastics material over the back surface of the lens and around its periphery.

In order to provide protection for the eyelid against irritation by contact with the convex, front surface of the lens, the front surface may also be provided with a layer of relatively soft and flexible plastics material which is integral with the skirt so that the lens is enclosed within a sheath of soft plastics material. In this form of construction the lens cannot come into contact with either the eyeball or the eyelid and thus provides maximum protection against irritation or damage to the eye by the conventionally used hard plastics lenses.

The plastics materials which are conventionally used for the manufacture of contact lenses are acrylic plastics of optical quality, in particular homopolymers of methyl methacrylate and of ethyl acrylate, as well as copolymers of methyl methacrylate with ethyl acrylate. It has been found, however, that epoxy resins may also be used advantageously as the material of the lens.

There is a wide choice of plastics which are suitable for the skirt and the choice is only limited by the requirements that the selected plastics material should be non-irritant to the eye, should exhibit the necessary degree of softness and flexibility, should preferably be capable of forming a bond with the plastics material of the lens, and, except in the case of occluding lenses, should be transparent.

Soft epoxy plastics have been used successfully as the material for the skirt, particularly in conjunction with a lens made of epoxy resin. As is known in the plastics art, unmodified epoxy resins tend to be hard materials when fully cured and are not readily

[Price

softened by the incorporation of the usual plasticisers. Epoxy resins can be softened and rendered more flexible, however, by chemical modification with various substances which react with some of the epoxide groups, examples of suitable modifying substances being polyoxyalkylene polysulphide polymers (e.g. the liquid "Thiokol" polysulphides, the word "Thiokol" is a Registered Trade mark) and polyamides (e.g. those sold under the Registered trade mark "Versamid". As the material of the lens, therefore, one may use an unmodified epoxy resin (produced, for example, by alkali condensation of bisphenol A and epichlorhydrin), while the skirt may be made from an epoxy resin which has been chemically modified while in the uncured state so as to render it softer and more flexible or from a mixture of modified and unmodified epoxy resins. An example of a suitable epoxy resin for use as the material of the lens is the material sold under the trade designation "Dow Resin 331" and cured with 29% by weight of the amine hardener sold under the trade designation "Bakelite D.Q. 19262", the words "Bakelite" and "Dow" being registered trade marks. As the material of the skirt one may employ a mixture of the epoxy resins sold under the trade designations "Dow Resin 331" and, "Dow Resin 732" in the proportions of 75% of the former to 25% of the latter and cured with the same amount of the above mentioned "Bakelite" hardener.

Other plastics which are suitable for the material of the skirt include polyvinyl chloride and copolymers of vinyl chloride and vinyl acetate, fluorinated copolymers of ethylene with propylene and polyester plastics. Polyvinyl chloride-based plastics may be softened and rendered more flexible by the incorporation of plasticisers.

In selecting the material to be used for the sheath, it is necessary that the flexibility thereof shall not be so great as to give rise to the possibility of the skirt or edge of the sheath folding back under the lens when the assembly rides on the surface of the eye during normal use.

The plastics lens should be at least as big as the diameter of the pupil of the eye and a practical minimum size is 6 millimeters in diameter, while a suitable thickness for the layer of softer, more flexible plastic over the lens is about 0.02 millimeters. The existence of the flexible skirt ensures that the assembly is more easily kept in place and the flexibility of the material ensures not only a lack of irritant effect either on the eyelid or eyeball surface, but also ensures that the necessary "tear-cushion" can form between the cornea and the lens assembly to prevent "wear" damage to the eye.

The manner of manufacturing the assemblies of the present invention depends to some extent on the nature of the material selected for the skirt. The use of thermoplastic materials for the skirt is best suited to cases when the lens is entirely enclosed within a sheath of relatively soft and flexible plastic. In one method, of producing such a contact lens assembly, a preformed lens (manufactured from a conventional plastics material in the customary manner) is placed between a pair of saucer-shaped members of softer and more flexible plastics material whose edges overlap the edge of the lens. By sealing the edges of the two saucer-shaped members together, the lens is enclosed and this operation is preferably carried out in a heated mould so that the edges of the saucer-shaped members can be made to flow together and form a peripheral skirt of the desired shape.

Preferably the assemblies of the present invention are constructed from a composite blank in which a layer of optical quality plastics material is bonded to a layer of softer and more flexible plastics material and this method of manufacture is best suited to cases where both the skirt and lens are formed from thermosetting resins such as epoxy polyester resins.

The invention includes a method of manufacturing a contact lens assembly which comprises shaping a cured plastics blank comprising a layer of optical quality plastics material bonded to a layer of softer and more flexible plastics material by cutting a concave cavity into a layer of optical quality plastics material through the layer of softer and more flexible plastics to form the back surface of the assembly, and by cutting the opposite face of the blank to form a convex front surface of the assembly. A larger area of contact between the two different plastics can be achieved by using a blank which itself has concave and convex outer surfaces, with optical quality plastics material having a convex outer surface, while the softer, more flexible plastics material has a concave outer surface. With the wider scarf joint formed between the skirt and the lens in this way, there is a more gradual variation of hardness and flexibility across the surface of the assembly. A similar effect can be achieved by using a blank formed from more than two layers or plastics having different physical properties so that the degree of hardness gradually decreases and the flexibility gradually increases through the blank in a direction away from the plastics material of optical quality.

An alternative but less preferred method of manufacturing the contact lens assemblies of the present invention comprises shaping a blank comprising a cylinder of optical quality plastics material embedded in a flat slab of softer, more flexible plastics material, the axis of the cylinder being at right angles to the plane of the slab. Such a blank is readily formed by filling a cylindrical hole in a slab of relatively soft and flexible plastics material

with optical quality plastics material, while in an uncured condition, and then curing the optical quality plastics material which bonds firmly to the softer and more flexible plastics material.

Several embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figs. 1 to 5 indicate different embodiments of the invention;

Figs 6, 7 and 8 indicate a method of producing the assembly of the invention;

Figs 9 and 10 indicate an alternative method; and

Figs 11 and 12 indicate a further alternative method.

In Figure 1, a lens 1 of optical quality plastics material is provided with a peripheral skirt 2 made of a softer and more flexible plastics material, the inner edge of the skirt being bonded to the outer edge of the lens. In the assembly shown in Figure 2 the back surface of the lens is coated with a layer 3 of relatively softer and flexible plastics material which is integral with the skirt 2. Figure 3 shows an assembly similar to that of Figure 2 in which the front surface of the lens also is coated with a layer 4 of relatively softer and flexible plastics material. Slightly different types of assemblies are shown in Figures 4 and 5, Figure 4 showing a construction in which a lens 5 is coated on its back surface with a layer 6 of relatively softer and flexible plastics material which extends laterally to form the peripheral skirt 2. The construction of the assembly shown in Figure 5 is essentially the same except that a layer 7 of relative softer and flexible plastics material is over the front surface of the lens and, together with the layer 6 forms a sheath totally enclosing the lens 1.

Referring to Figs. 6 to 12, Figure 6 shows a blank constructed from a layer of optical quolity plastics material 1 bonded to a layer of softer and more flexible plastics material 2. After cuting away the blank to form the back surface of the lens, for example on a lathe using a diamond or steel cutting tool, the blank has the shape as shown in Figure 7. The front surface of the lens may also be cut on a lathe and Figure 8 shows a cross-section of the joint between the skirt and the lens after this operation has been carried out. Figure 9 shows a blank similar to that shown in Figure 6 but which has been curved prior to curing the plastics and Figure 10 shows the greater area of contact between the skirt and the lens when a lens assembly is cut from a blank of this kind. A blank produced by filling a cylindrical hole in a flat slab of relatively softer and flexible plastics material with an optical quality plastics material is shown in Figure 11, while the nature of the joint between the skirt and the lens is apparent from Figure 12.

While it is essential for the softer and flexible plastics material to be transparent in the production of normal contact lenses, the invention is also applicable in the production of occluding lenses, in which case the plastics material of the skirt may be entirely translucent or opaque.

It will be appreciated that by using the invention described herein it is possible to reduce very greatly the number of differently shaped lenses which are required, as the skirt of the sheath does itself inherently conform to the shape of the individual eye. It is envisaged therefore that the range of stock sizes of lenses will be all that is required.

WHAT I CLAIM IS:—

1. A plastics contact lens assembly which comprises a contact lens having a peripheral skirt which is shaped to conform with the surface of the eyeball and which is constructed from a plastics material which is softer and more flexible from that of the lens.

2. An assembly according to claim 1 wherein a layer of plastics material, which is softer and more flexible than that of the lens, extends over the concave back surface of the lens and is integral with the skirt.

3. An assembly according to claim 2 wherein a layer of plastics material, which is softer and more flexible than that of the lens, extends over the convex front surface of the lens and is integral with the skirt so that the lens is totally enclosed within a sheath of plastics material which is softer and more flexible than that of the lens.

4. An assembly according to any one of claims 1 to 3 wherein the skirt is constructed from two or more plastics materials of different degrees of hardness and flexibility so that there is a gradual decrease in the hardness of the assembly coupled with an increase in flexibility from the lens towards the edge of the assembly.

5. An assembly according to any one of the preceding claims wherein the lens and skirt are both constructed from epoxy resins.

6. An assembly according to any one of claims 1 to 4 wherein the lens is constructed from a homopolymer of methyl methacrylate or of ethyl acrylate or from a copolymer of methyl methacrylate with ethyl acrylate.

7. An assembly according to claim 6 wherein the skirt is constructed from a homopolymer of vinyl chloride, a copolymer thereof with vinyl acetate or from a fluorinated copolymer of ethlene and propylene.

8. A method of manufacturing a contact lens assembly as claimed in claim 1 which comprises shaping a cured plastics blank comprising a layer of optical quality plastics material bonded to a layer of softer and more flexible plastics material by cutting a concave

cavity into the layer of optical quality plastics material through the layer of softer and more flexible plastic to form the back surface of the assembly and by cutting the opposite face of the blank to form the convex front surface of the assembly.

9. A method according to claim 8 wherein the blank itself has concave and convex outer surfaces, the optical quality plastics material having a convex outer surface, while the softer, more flexible plastics material has a concave outer surface.

10. A method according to claim 8 or 9 wherein the softer and more flexible plastics material is in the form of a plurality of layers of plastics materials having different degrees of hardness and flexibility, the degree of hardness decreasing and the flexibility increasing through the blank in a direction away from the plastics material of optical quality.

11. A method of manufacturing a contact lens assembly according to claim 1 which comprises shaping a blank comprising a cylinder of optical quality plastics material embedded in a flat slab of softer and more flexible plastics material, the axis of the cylinder being at right angles to the plane of the slab.

12. A method of manufacturing a contact lens assembly as claimed in claim 3 which comprises sandwiching the lens between a pair of saucer-shaped members of softer and more flexible plastics material which overlap the edge of the lens and sealing the edges of the saucer-shaped members together to form the skirt.

13. A contact lens assembly substantially as described with reference to Figures 1 to 5 of the accompanying drawings.

14. A method of manufacturing a contact lens assembly substantially as described with reference to Figures 1 to 7 of the accompanying drawings.

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Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

FIG.1.

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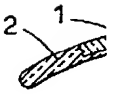

FIG.3.

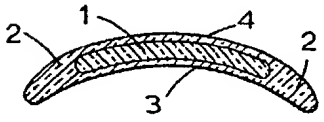

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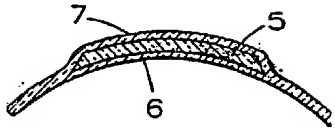
FIG.5.



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2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 1 & 2

FIG.6.

FIG.7.

FIG.8.

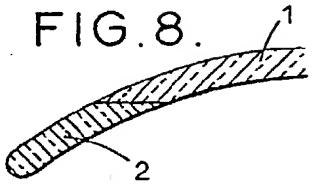

FIG.9.

FIG.10.

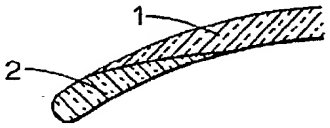

FIG.11.

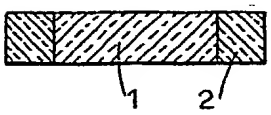

FIG.12.

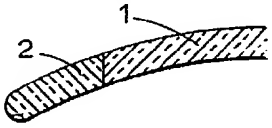

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FIG.1.

FIG.2.

FIG.3.

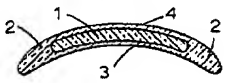

FIG.4.

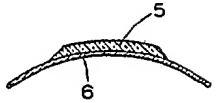

FIG.5.

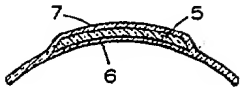

FIG.6.

FIG.7.

FIG.8.

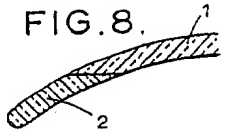

FIG.9.

FIG.10.

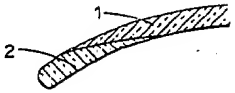

FIG.11.

FIG.12.